

Attorney Docket No.: 0140111

REMARKS

Prior to the present amendment, claims 1, 3-6, 9-14, 16, 18, and 19 were pending in the present application. By the present amendment, claims 1, 9, and 16 have been amended. Thus, claims 1, 3-6, 9-14, 16, 18, and 19 remain in the present application. Reconsideration and allowance of outstanding claims 1, 3-6, 9-14, 16, 18, and 19 in view of the above amendments and the following remarks are respectfully requested.

A. Rejections of Claims 1, 3-6, 9-14, 16, 18, and 19 under 35 USC §103(a)

The Examiner has rejected claims 1, 3-6, 9-14, 16, 18, and 19 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent Number 6,521,997 to Huang et al. (hereinafter "Huang") in view of U.S. Patent Number 6,693,239 B2 to Myers et al. (hereinafter "Myers"). For the reasons discussed below, Applicants respectfully submit that the present invention, as defined by amended independent claims 1, 9, and 16, is patentably distinguishable over Huang and Myers, either singly or in combination thereof.

As disclosed, the present invention includes a surface mount component (SMC) situated over a substrate, such as a laminate circuit board, in an MCM (multi-chip module). In an embodiment of the invention, solder mask trench 124 is formed in solder mask 112 underlying SMC 102, where solder mask trench 124 is formed in a region under SMC 102 in which soldering does not take place. Thus, solder mask trench 124 is formed where, in the absence of the present invention, no solder mask opening would be formed. More particularly, as shown in Figure 3 of the present application, solder mask

Attorney Docket No.: 0140111

trench 124 is formed within, i.e. between portions of, solder mask 112. By forming solder mask trench 124 underneath the surface mount component and within solder mask 112, moldable gap 125 is advantageously formed with increased height 128 such that it (i.e. moldable gap 125) is substantially larger than a conventional moldable gap. By contrast, in a conventional structure, solder mask 112 would fill the region between pads 106 and 108 underneath the SMC. As a result, a conventional moldable gap that would be formed between solder mask 112 and the bottom surface of the SMC would have a reduced height 130, as shown in Figure 1 of the present application.

Thus, by forming solder mask trench 124 under SMC 102, an embodiment according to the present invention advantageously achieves a significantly larger moldable gap, having height 128, thereby improving molding compound flow underneath the SMC and, consequently, minimizing void formation underneath the SMC in the MCM. As a result, embodiments according to the present invention advantageously minimize the risk of shorting between the terminals of the SMC during, for example, reflow assembly, thereby significantly increasing the reliability of the SMC.

In contrast to the present invention as defined by amended independent claims 1, 9, and 16, Huang is directed to providing a chip carrier for accommodating a passive component, which can “prevent the occurrence of short circuit between the passive component and solder pads.” Huang, column 2, lines 19-22. Huang specifically discloses chip carrier 1 including core layer 10, which includes chip attach area 100 for mounting a

Attorney Docket No.: 0140111

chip thereon and trace forming area 101 surrounding chip attach area 100. *See, e.g.,* column 3, lines 5-10 and Figure 1 of Huang.

On page 2 of the Office Action dated February 5, 2008, the Examiner has stated that Huang discloses “a module comprising: a surface mount component (elements 15, 15' Figs 1-4) situated over a laminate circuit board (elements 10, 1' Figs 1-4)” However, Applicants submit Huang fails to disclose or suggest the use of a laminate circuit board in an MCM as disclosed and claimed by the present invention. In fact, Huang actually teaches away from the use of a laminate circuit board in an MCM by disclosing that: “chip carrier 1' [sic] of the second embodiment [shown in Figure 4 of Huang] is structurally identical to that of the first embodiment [shown in Figures 1 and 2 of Huang], as both are a substrate for use in a BGA (ball grid array) semiconductor package.” Huang, column 4, lines 5-8.

Thus, Huang is directed to a discrete chip packaging technology and not to an MCM comprising a laminate circuit board, as specified in amended independent claims 1, 9, and 16. The chip carrier in a BGA package disclosed by Huang is not analogous to a laminate circuit board in an MCM. The BGA package disclosed in Huang is intended to be mounted onto and supported by a laminate circuit board, such as that specified in amended independent claims 1, 9, and 16.

Also, as shown in Figure 1 of Huang, only the trace forming area 101 is applied with solder mask layer 11 for covering the conductive traces on trace forming area 101. *See, e.g.,* column 3, lines 12-15 of Huang. Thus, Huang also fails to disclose or suggest a

Attorney Docket No.: 0140111

solder mask that uniformly covers a top surface of a laminate circuit board, as specified in amended independent claims 1, 9, and 16.

Thus, Huang fails to disclose or suggest an overmolded module including a solder mask trench that is situated over a top surface of a laminate circuit board, where a solder mask uniformly covers the top surface of the laminate circuit board, where the overmolded module is an MCM, and where the solder mask trench minimizes void formation in the molding compound underneath the surface mount component in the MCM, as specified in amended independent claims 1, 9, and 16.

On page 3 of the Office Action dated February 5, 2008, the Examiner has correctly acknowledged that Huang “does not expressly disclose wherein the overmolded module is an MCM.” In an attempt to overcome this deficiency, the Examiner has cited Myers to combine with Huang. Myers relates to an overmolded circuit board and process by which the circuit board is overmolded and a surface-mount device, such as a flip chip, on the circuit board is simultaneously underfilled with the overmold material, without the creation of voids between the device and circuit board. *See, e.g.,* column 1, lines 17-24 of Myers. Myers specifically discloses overmolded housing 30 including circuit board 12, chip 14, and molding material 16. *See, e.g.,* Figure 4 and related text of Myers. In Myers, chip 14 is mounted on circuit board 12 over cavity 20 and encapsulated in molding material 16. *See, e.g.,* Figure 4 and related text of Myers.

In Myers, cavity 20 is centrally located in the surface of circuit board 12 beneath chip 14 and is intended to accommodate air during a molding process in which chip 14 is

Attorney Docket No.: 0140111

underfilled while circuit board 12 is simultaneously overmolded with the same molding material 16. *See, e.g., Myers*, column 3, line 60, through column 4, line 2. During a molding operation, molding material 16 fills the mold cavities on either side of board 12 and also completely fills gap 22 between chip 14 and board 12 so as to cause entrapped air to be contained within cavity 20, thereby isolating the entrapped air in a non-critical area of circuit board 12. *See, e.g., column 4, lines 8-57 and Figures 3 and 4 of Myers*. As a result, the air entrapped within cavity 20 does not contact the lower surface of chip 14 and, therefore, does not have a detrimental effect on the thermal life cycle of chip 14. *See, e.g., column 4, lines 54-57 of Myers*.

However, *Myers* does not disclose or suggest a solder mask trench for minimizing void formation in a molding compound underneath a surface mount component in an MCM, as specified in amended independent claims 1, 9, and 16. In fact, *Myers* does not even disclose the use of solder mask on the top surface of circuit board 12. Thus, *Myers* fails to cure the deficiencies of *Huang* discussed above. Thus, Applicants submit that the Examiner's suggested combination of *Huang* with *Myers* does not and cannot result in the claimed invention.

On page 3 of the Office Action dated February 5, 2008, the Examiner states that "it would have been obvious to one skilled in the art at the time the invention was made to have included an MCM as taught by *Myers et al* in the device as taught by *Huang et al* as MCMs are commonplace in the art, and are commonly molded in order to provide for good thermal dissipation" Applicants disagree with the Examiner. *Huang* is directed

Attorney Docket No.: 0140111

to preventing solder shorts from occurring as a result of voids created in resin material underneath a surface-mounted passive component on a chip carrier. In contrast, Myers is directed to forming a cavity in a circuit board underneath a chip as to entrap air in the cavity during a molding operation, thereby preventing the entrapped air from contacting the lower surface of the chip and detrimentally affecting the chip's thermal life.

In Huang, a recess is formed in the solder mask to create a large passage to allow resin material to pass through an overlying surface-mounted passive component. However, in Myers, the molding material is appropriately selected to allow it (i.e. the molding material) to flow readily in the gap formed between the chip and circuit board during the overmolding/underfilling operation. *See*, e.g., column 4, lines 8-20 of Myers. Thus, the solder mask recess formed in Huang would have no purpose in Myers. In fact, Huang's solder mask recess would not function to entrap air underneath a chip, as required in Myers. As such, Applicants submit that a person of ordinary skill in the art, at the time the invention defined by amended independent claims 1, 9, and 16 was made, would not reasonably combine Huang with Myers, as suggested by the Examiner.

For the foregoing reasons, Applicants respectfully submit that, at the time the invention defined by amended independent claims 1, 9, and 16 was made, the invention would not have been obvious to a person of ordinary skill in the art by Huang and Myers. Thus, amended independent claims 1, 9, and 16 are patentably distinguishable over Huang and Myers and, as such, claims 3-6 depending from amended independent claim 1, claims 10-14 depending from amended independent claim 9, and claims 18 and 19

Attorney Docket No.: 0140111

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depending from amended independent claim 16 are, *a fortiori*, also patentably distinguishable over Huang and Myers for at least the reasons presented above and also for additional limitations contained in each dependent claim.

B. Conclusion

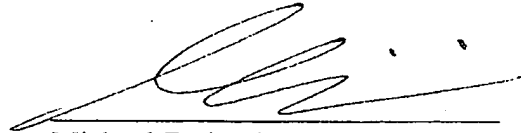
For all the foregoing reasons pending claims 1, 3-6, 9-14, 16, 18, and 19 are patentably distinguishable over the cited art, and an early allowance of pending claims 1, 3-6, 9-14, 16, 18, and 19 is respectfully requested.

Attorney Docket No.: 0140111

Respectfully Submitted,
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